PROGRESS REPORTS

FROM

EXPERIMENT STATIONS

SEASON 1959-60

NORTHERN NIGERIA

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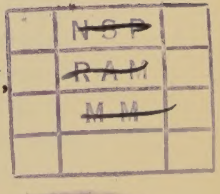

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SAMARU, ZARIA PROVINCE

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NORTHERN NIGERIA
PROGRESS REPORT FOR THE SEASON 1959-60

Sowing period: June to September.
Picking period: November to March.
Close season: April to June.

General Introduction

BY

H. E. KING and J. M. MUNRO

Season and General

The 1959-60 season, although differing from that of 1958-59 in that the total rainfall was higher, was again a thoroughly unfavourable one for the commercial cotton crop. Poor and badly distributed early rains throughout the greater part of the main producing areas again delayed the sowing of food crops and also much of the groundnut crop. As a result of this a very large part of the cotton crop was also planted far later than the optimum time.

The weather subsequent to sowing was not such as to reduce the ill-effect of this delay, but on the contrary intensified it: excessive rain in late August and the earlier part of September hindered the setting of fruit and thereafter the abrupt and unusually early end of the rainy season (during the third week of September over much of the country) completed the sequence of factors unfavourable to both yield and quality.

In consequence a seed issue slightly larger than that of the previous two seasons resulted in a crop of 163,197 bales of Allen type cotton, in contrast with 170,555 bales in 1958-59 and 233,033 bales in 1957-58.

This result is all the more disappointing in the light of the good yields obtained from timely sown, well treated cotton plots on the experiment stations where the primary difficulty facing the peasant farmer—the need to give priority to his food crops—is not limiting.

Rainfall at Samaru (see Table 1) and at Daudawa followed the pattern indicated above but, with a combination of early sowing, the use of fertilisers (phosphatic and nitrogenous) and the application of insecticides, the season could in fact be described as at least as good as the previous two. Once again a yield of over 2,000 lb of seed cotton per acre was obtained from one plot at Samaru and the average yield for 224 acres at Daudawa was over 580 lb. An area of 94 acres of sprayed cotton at Mokwa (a locality not notable for high yields in the past) averaged 760 lb per acre; other experimental plots, not protected by insecticides but timely sown, gave yields not inferior to those of the previous two seasons. There is little doubt, therefore, that the delayed sowing alone accounted for the major part of the drop in size of the commercial crop.

TABLE 1

SUMMARY OF METEOROLOGICAL DATA AT SAMARU, 1959

Month	*Rainfall (inches)*		*Days rain*		*Relative humidity %*				*Air temperature °F (screen)*				*Sunshine daily mean (hours)* (1)		*Open pan evaporation (inches)* (2)	
	1959	1924 -59	1959	1928 -59	1959 10 a.m.	1959 4 p.m.	1954 -59 10 a.m. av.	1954 -59 4 p.m. av.	1959 max.	1959 min.	1938 -59 max.	1938 -59 min.	1959	1954 -59	1959	1954 -59
January	0·00	0·00	—	—	17·9	13·2	20·7	16·6	85·0	58·2	88·3	57·6	8.5	9.1	7·84	7·20
February	0·00	0·06	—	—	11·0	10·1	17·4	12·2	90·3	61·6	91·4	60·6	9·5	9·5	8·58	7·80
March	0·27	0·38	1	1	28·5	15·8	30·5	17·3	95·7	67·4	96·1	67·2	9·5	9·0	9·60	8·88
April	1·87	1·30	3	3	47·0	23·5	53·3	29·8	96·8	71·3	97·2	71·1	8·5	8·0	8·38	7·43
May	4·66	5·32	13	11	64·6	45·3	64·9	45·1	90·9	69·9	91·7	70·1	8·9	8·4	7·68	7·01
June	6·65	6·34	12	13	72·0	57·3	76·1	61·1	87·0	67·9	87·8	68·1	8·6	7·9	6·42	5·61
July	6·23	8·72	14	17	78·0	65·0	80·0	67·7	84·0	67·0	83·4	67·3	6·8	5·9	5·76	4·88
August	10·84	11·62	22	22	84·9	74·4	83·4	71·5	80·2	66·8	81·9	66·9	3·9	4·7	3·73	4·29
September	11·32	8·95	19	17	78·2	68·2	77·2	64·4	83·4	65·8	84·8	66·6	6·2	6·6	5·13	5·00
October	0·03	1·46	1	4	48·9	29·9	60·1	44·6	88·9	62·5	89·0	65·2	10·2	9·0	5·97	5·72
November	0·00	0·04	—	—	25·6	15·1	33·8	21·4	90·4	59·4	90·2	60·7	10·3	9·9	6·66	6·28
December	0·00	0·00	—	—	16·5	9·7	23·2	17·4	85·9	55·1	87·9	57·7	9·4	9·7	7·20	6·81
Totals	41·87	44·19	85	88	—	—	—	—	—	—	—	—	—	—	82·95	76·91
Means	—	—	—	—	47·8	35·6	51·7	39·1	88·2	64·4	89·1	64·9	8·4	8·1	6·91	6·41

(1) Campbell-Stokes sunshine recorder.

(2) From sunken tank 6′ × 6′; not corrected for errors due to splash.

Until this obstacle can be overcome the use of fertilisers, insecticides, and indeed of improved varieties and all other measures for increasing yields, will be virtually ineffective save in particularly favourable seasons and at best therefore will merely increase the magnitude of the seasonal fluctuations in the size of the crop.

Of the 16,924 tons of seed issued for sowing the commercial crop 68% was strain Samaru 26J, the remainder being 26C and a small tonnage of Benue. Both these latter are being replaced by 26J in 1960-61.

About 5% of the seed issue was dressed with Agrosan 5W; with the installation of continuous flow seed dressing machinery at the Funtua ginnery this proportion has been raised to over 40% for the 1960-61 season.

The experimental work at Samaru, and the various substations throughout the region, continued on established lines. The isolation and testing of substrains of Allen origin continued, and has given selections showing improved yield and spinning quality. The use of the selection index over four seasons was reviewed. Modal and positive bulks were established in 1959-60, and selections screened for planting in 1960-61. A number of hybrids were under trial for the first time.

Further progress has been made in studies of methods of rainfall conservation while avoiding surface flooding, and it appears that placing ties in alternate furrows is a safe and profitable practice for all three of the major field crops—cotton, sorghum and groundnuts. "Vertical mulching", inserting groundnut shells in a slit in the furrow bottom, gave encouraging results in a first trial.

All known methods of plant inoculation to measure resistance to bacterial blight of cotton were tested; none could be considered satisfactory for Nigeria.

Entomological studies are leading to more definite knowledge of the conditions under which insecticides will give an economic return. The combination of protection against insect attack with early sowing and fertiliser applications has proved particularly successful in the Riverain Provinces.

Staff, Buildings and Land

Mr. H. E. King left Samaru on retirement at the end of May 1960, after eleven years as senior officer of the Corporation in Northern Nigeria; for his services to the cotton industry he was awarded the O.B.E. in the Birthday Honours List in 1958. He is succeeded at Samaru by Mr. J. M. Munro, who arrived in April 1960.

Mr. J. H. Gisborne, Secretary for Research and Specialist Services, retired in February 1960; he had been in charge of the Regional

Research Station at Samaru since November 1957. Previously, as Botanist, Mr. Gisborne handed over the cotton breeding work to Mr. King in 1949.

Mr. B. E. Costelloe joined the staff as a plant breeder in September 1959.

The following members of the staff were on leave during the year:

M. A. Choyce ..... July-October 1959
D. A. Lawes ..... March-August 1959
W. Reed ..... March-August 1960
B. J. S. Lee ..... March-July 1960

Following a request for advice on cotton growing matters from the Government of the Western Region of Nigeria, Mr. Choyce and Mr. Reed visited Ibadan and the Ishan multiplication area at Meko during December 1959. Insecticide and date-of-sowing trials are being carried out on 26J, as well as Ishan, in the Region.

Mr. F. Tasker, Agricultural Superintendent, was transferred to the Field Services Division in May 1960. Junior Service recruits with the necessary educational qualifications are still slow in coming forward to fill the vacancies resulting from the policy of northernisation.

No start has yet been made on the proposed new laboratories, and laboratory and storage space remains inadequate.

Blocks T.8-15 and U.2-6 of the new extension to Samaru, totalling about 70 acres, were cropped for the first time. The fields have been laid out on graded terraces, and are at the moment less uniform than those which have been cropped for some time.

Plant Breeding

BY

J. M. MUNRO, B. J. S. LEE and B. E. COSTELLOE

Tests of Small Bulks and Strains

A survey of the trial results over the last three seasons shows that there are two outstanding strains, one for yield and the other for spinning quality. The former, S56, mentioned in the last two reports as 479-25 BCP/14, is a high yielding selection with slightly shorter lint than 26J. The mean yield of lint this season in 11 trials, four at Samaru and seven district trials, was 14% higher than 26J; spinning tests on the 1958-59 trials confirmed that lint quality was below the present standard, but yarn appearance was half a grade better (Table 2). Although as it stands S56 is not suitable for distribution, much of the selection work is now concentrated on this strain, looking for better lint quality combined with its high yielding ability.

TABLE 2

COTTON VARIETY TRIALS

Variety	*Lint lb per acre*	*Gin %*	*Wt of 100 seeds g*	*Count × strength at 40s*	*Yarn appearance*
	1959-60, 11 trials			*1958-59, 8 tests*	
New Blend 26J	169	35·0	8·4	2144	3·6
S56	191	36·1	8·6	2071	3·0
	1957-60, 3 trials			*1957-59, 2 tests*	
New Blend 26J	279	35·3	8·8	1970	4·0
S49	299	36·1	8·4	2310	2·5

The second strain, S49, is one of the 49160 group with a high reputation for spinning quality; this group has given rather erratic yields in past seasons, but on average is at least equal to 26J. S49 has shown a count × strength product more than 300 higher than the present standard in small scale spinning tests in two consecutive seasons.

Four other strains in the district variety trials showed small improvements over 26J, and are carried forward for further testing, together with three from the strains test.

S52 Selections—Selection Index

One progeny row trial of 49 varieties has been devoted each year since 1956-57 to the use of the selection index. Three lines were included in the first two years, but one of these has been discarded and another was represented by only six progenies this season. The remaining line will occupy a complete trial in 1960-61; this, S52, is one of the components of 26J, known as 26C/479-25-44.

Two important points have emerged from the use of the selection index at Samaru. Firstly, the index can only be applied within closely related groups of material; if more than one group is included in a trial, a separate index for each is required. The second point is that up to 1958-59 the index has selected the same progenies as selection on yield alone; in 1959-60 there are, however, two cases in which progenies were included on one method but rejected on the other.

TABLE 3

ADVANCE IN LINT YIELD OF S52 AND S49 PROGENIES AND SELECTIONS

Differences from mean of 26J control in lb per acre

	1956		1957		1958		1959	
	Trial	Selns.	Trial	Selns.	Trial	Selns.	Trial	Selns.
S52								
Observed	− 8	+38	+ 9	+40	+23	+63	+17	+34
Calculated	—	—	—	+ 2	—	+24	—	+ 7
Cumulative[1]	—	—	+ 9	—	+29	—	+53	—
No. in mean	15	5	12	3	32	6	41	13
S49								
Observed	+ 3	+20	+27	+56	+ 4	+67	+17	+42
No. in mean	16	6	12	3	14	1	6	1

[1]Observed for 1957, calculated for 1958 and 1959

Table 3 displays the lint yield advance of the progenies and the selections made in the last four years. The calculated selection advance is seen to be appreciably higher than the advance actually made. The line S49 shows more season to season variation than S52; similar variation has been seen in other yield trials.

S56 Selections—Modal Bulk

An appreciable amount of natural outcrossing appears to take place at Samaru, and there are difficulties in maintaining pure stocks without hand selfing; there are also theoretical reasons why a cross-pollinated stock may not remain stable from year to year. A start was made in 1958 to establish a modal bulk as a standard control for yield trials. The variety chosen was S56, the high yielding strain mentioned above, which was known as 26C/479-25 BCP/14. The procedure adopted was that used at Namulonge—successive screening for lint index, seed weight and lint length.

At the same time a positive bulk was made up by setting minimum standards for ginning percentage, lint length and yield. The high extremes were also eliminated as these are likely to be due to heterosis. Similarly a negative bulk was made up with low maximum standards for the three characters. These three bulks were tested against the original bulk in two Latin squares, but no significant difference could be demonstrated in this first season.

S56 Selections—Special Character Bulks

The same material as provided the modal bulk (1,000 random plants in 1958-59) was used to study the effect of selection on single characters. Five bulks were planted in 1959-60 made up from single plants selected for the following:

High number of seeds per boll.
Low number of seeds per boll.
High seed weight.
Low seed weight.
High lint per seed.

One hundred selfed plants from each bulk were taken for analysis, but showed no significant difference between the means of contrasted characters. The plants from each bulk were again selected for the same characters, and made up into fresh bulks for planting in 1960-61.

S56 Selections—Special Character Progenies

Using the same material, individual plants were selected for improved ginning percentage, lint yield and halo length, and grown in progeny rows. The object was to study the effect of tandem selection,

that is, improving one trait at a time. Correlations between plant and progeny were computed for each character within its group, but none was significant.

Hybridisation

Work was continued on the hybrids remaining from those made in 1954 (see Progress Report for 1954-55). Five combinations of crosses and backcrosses have been made in each of the two crosses 26I × MU8A and 26I × BAR D28. These were put into the small bulks test for 1959-60; one from the former cross and two from the latter were kept for testing next year. Only one, derived from the 26I × BAR D28 material, gave a better yield than New Blend 26J. Single plant selections were chosen from each of the crosses not included in the trial, and examined in the laboratory for ginning percentage and lint length; of these, fourteen showed some desirable characters and were retained for further testing.

The panmixis bulks grown annually at Gusau, Gombe, Kontagora and Samaru were once more sown and allowed to produce seed by unrestricted natural pollination. A parallel series of plots is grown at Samaru only, using the same material but with the difference that cross pollination is aided by the daily use of a camelhair brush. A series of single plant selections and a random bulk were taken from these brush-pollinated plots in 1957 and selfed in 1958; these were tested this year in the small bulks test. The performance of the random bulk was undistinguished, but two of the single plant progenies were retained for further testing. Both had a higher ginning percentage than 26J, although the lint yield was slightly lower.

Further progress has been made in producing a cultivar similar to 26J but incorporating the recessive marker gene "glandless". The aim is to produce a type suitable for use in determining the amount of natural outcrossing at Samaru. The programme involves the repeated backcrossing of 26J to glandless, with selection of the glandless plants nearest to the 26J type.

Crop Physiology

BY

D. A. LAWES

For the third successive season a high yield of cotton has been produced from a half-acre field which has been given all treatments which are considered beneficial. This year these treatments included: early preparation of land; application of two tons per acre of night soil compost; ridging and cross-tying to conserve rainfall; "vertical

mulching" using groundnut shells to improve infiltration; timely sowing (29th June) with acid-treated and Agrosan-dressed seed of 26J; fertilising with 165 lb single superphosphate and 137 lb sulphate of ammonia per acre by placement; and spraying with DDT/BHC insecticide ten times.

The yields of seed cotton per acre for the three seasons have been:

1957 ..... 1,930 lb.
1958 ..... 2,246 lb.
1959 ..... 2,206 lb.

The first season was excessively wet, the second very dry, and the third about average in total rainfall but with bad distribution. The yield has been maintained at a high level, despite these large variations in rainfall, which are generally assumed to be the main factor in causing seasonal fluctuations. Also, all three crops have been ready for harvest before the end of the year, whereas on other plots, often yielding very much less, picking has had to continue two to three months later.

Work continued on designing and testing techniques for conserving rainfall, improving infiltration of rainfall into the soil and improving soil aeration. The background and results of this work will be published elsewhere; only a brief reference to two of the more interesting results obtained this season follows here.

This year a technique developed in America under the name of "vertical mulching" was tried. An experiment last year showed an increase in seed cotton yield from slitting the furrow bottom to a depth of 12″ to 14″ with a subsoiling tine. This improves infiltration temporarily, but after a few storms, silting up of the fissure occurs and the effect is nullified. Vertical mulching is the term used for placing a mulch in the slit to keep it open. This season groundnut shells were used as a vertical mulch in a slit 10″ deep, and the treatment gave an increase of 222 lb per acre (21·7%) over the normal tied furrows which yielded 1,026 lb seed cotton per acre.

This increase in yield is attributed to the immediate infiltration of the rain; normal tied ridges hold standing water for periods after each rainstorm, and standing water is known to depress yields of cotton in some years of heavy or badly distributed rainfall.

A more practical method of reducing the standing water is to leave alternate furrows without cross ties. Surface drainage from the open furrows allows aeration of the rooting zone while the crosstied furrows trap a proportion of the rain. Table 4 gives yields from trials of this method on all three major crops at Samaru. The results illustrate the

depression in yield suffered this season by cotton (but not by the other two crops) with complete crosstying, and the increase shown by cotton and sorghum when alternate furrows were left open.

TABLE 4

YIELDS PER ACRE FROM CROSS-TYING EXPERIMENTS, AND (IN PARENTHESES) AS % OF CONTROL TREATMENT

Treatment	*Experiment I Cotton lb seed cotton*	*Experiment II Sorghum lb grain*	*Experiment III Groundnuts lb kernels*
All furrows left open (control)	576 (100·0)	1938 (100·0)	1087 (100·0)
All ridges tied throughout the season	541 (93·9)	1961 (101·2)	1105 (101·7)
Alternate furrows left open	638 (110·8)	2078 (107·2)	1125 (103·5)
All ridges tied but ties removed at height of rains	640 (111·1)	*	*
S.E.	±20·1 (3·48)	±31·4 (1·62)	±31·3 (2·88)

*This treatment not applied in experiments II and III

Alternate cross tying can be considered suitable for use by the farmer in preference to full cross tying, wherever infiltration is poor, until such time as an equally practical method can be evolved to improve infiltration, and the whole of the rainfall made available to the crop without the danger of standing water. It also fits in well with tractor operations, and could be used in the cotton seed multiplication scheme at Daudawa, where insecticide spraying by tractor-mounted equipment is now routine practice on parts of the farm; the tractor wheels can run in the alternate open furrows. As this technique requires surface drainage from the open furrows it does involve a soil conservation problem in dealing with the discharging water, but this is catered for at both Samaru and Daudawa, and the discharge is only half that of untied ridges.

Other studies continued in relating leaf areas to crop yield, on soil moisture variations through the season and the analysis of meteorological data.

PLANT PATHOLOGY

BY

M. DRANSFIELD

Not worth abst.

Studies of Bacterial Blight

Inoculation techniques.—All known methods of inoculating cotton with *Xanthomonas malvacearum* were tested on a field scale in an attempt to find one or more which could be used under Nigerian

conditions in selecting for blight resistance. Seedling blight, angular leaf spot and vein blight are the most important forms of the disease here; stem and boll infections occur infrequently.

(i) Seed inoculation. The most successful method of obtaining a high percentage of infected plants, without loss of stand, was that described by Wickens (1953), to soak fuzzy seeds for two hours in a suspension prepared from five 7-day-old petri-dish cultures of *X. malvacearum* per litre, without evacuation of the container, followed by drying the seeds thoroughly in a current of air before planting. If the seeds were inoculated under vacuum the germination was only 40%, although 87% of the resulting plants were diseased. Inoculation of acid-treated seeds produced negligible infection.

(ii) Leaf spraying. Eight varieties were sprayed when 5, 7 and 9 weeks old, using inocula containing nil, 6, 20 and 200 million viable bacteria per ml. Dale's infiltration method (Dale, 1958) was used to determine the period of maximal stomatal aperture, which is between 10 a.m. and 4 p.m. on a bright day.

This method was a failure. There was so much natural infection that there was no difference in disease level between the nil treatment and the highest concentration, although all diseased plants were rogued before spraying. It is possible that the sprayer used (Four Oaks four-gallon knapsack sprayer with swirl plate removed) had insufficient force to drive the bacteria into the leaf through the stomata. An Excelsior suction syringe from the same manufacturer, as used successfully at Shambat, will be tested next year, together with a more concentrated inoculum.

(iii) Needle inoculation into leaf midrib. Both young and mature leaves of eight varieties were inoculated by the method described by Last (1959) at various times between four and twelve weeks after sowing. A fine sewing needle was normally used; a coarser sewing-machine needle was suitable only under greenhouse conditions, because in the field the larger wound weakened the midrib, which was snapped by the wind and rain.

The following criteria were recorded: length of lesion, colour of lesion, spread of infection into mesophyll and lateral veins, and vascular symptoms in the leaf lamina. The lesion length was the most useful observation, although the colour was of great help in deciding the relative resistance of two lesions of similar size. Under field conditions there was little spread into the mesophyll with *G. hirsutum,* but in the few *G. barbadense* plants that were inoculated, mesophyll water-soaking commonly occurred.

The fourth to ninth leaves were the most susceptible, inoculated when the plants were between six and ten weeks old. The leaves of younger plants were too near the ground and became splashed with

mud. All leaves on plants more than ten weeks old were rather resistant. On plants of all ages, immature, partly expanded leaves were very resistant, as were leaves more than three weeks old.

(iv) Leaf abrasion method. Three methods were tried of recording the disease symptoms resulting from use of the method of Last and Dransfield (1959). (1) Grading on a 0-5 scale; (2) direct counts of the number of lesions per half-leaf; (3) estimating the number of lesions per square cm by comparing the diseased leaf with charts prepared to show the appearance of between one and 25 lesions per square cm. This last method was the most rapid and useful.

The standard inoculum was prepared by suspending one petri-dish culture, 7 days old, in 50 ml sterile water; this produced the highest lesion density, although a tenfold dilution of the standard was almost as effective and much less wasteful of media. Field inoculations on plants up to 8 weeks old produced a sufficiently high number of lesions for accurate grading coupled with a low coefficient of variation. Although this technique produces disease symptoms identical to natural angular leaf spots, it is a slow method, and not really suitable for use on a field scale. Variation between operators was high.

(v) Stem inoculation. Plants were inoculated by methods described by Wickens (1953) and Last (1958) when between 8 and 40 days old, using the topmost accessible internode. Although stem lesions were produced in greenhouse experiments, none was recorded in the field; a strong callus formed, and no water-soaking or darkening occurred although observations were continued until the plants were five months old. However, leaf vascular symptoms appeared in 45-81% of the plants (depending on variety) following inoculations below the cotyledons. When higher internodes were inoculated, vascular symptoms were less common. For example, in 26J they occurred in 10%, 4% and 1% of plants which had been inoculated in the 1st, 2nd and 3rd internode respectively.

(vi) Boll inoculation. All three methods (atomiser, brush and needleprick) described by Wickens (1953) and Logan (1958) were attempted, but no lesions resulted. Young bolls were inoculated by the first two techniques towards the end of the rains (late September), but by the time bolls were ready for needle inoculation the dry season was three weeks old and the humidity had fallen considerably.

Seed dressing.—A number of mercurial seed dressings were compared with Agrosan 5W in a small scale field experiment (1/130 acre per treatment). They included two organic and two inorganic Abavits, and organic and inorganic Granadin, Dieldrex A and Agallol. All dressings gave a substantial reduction in seedling blight, but none

of the less poisonous, inorganic, compounds was as effective as Agrosan and none of the organic compounds more than equally effective. Some of these will, however, be tested on a larger scale next season.

Samples of dressed seed were taken at frequent intervals from two newly installed seed dressing machines at Funtua ginnery in use for dressing the commercial seed issue for 1960. These were tested by the agar-plate assay method for rate and evenness of dressing.

Extent of seed infestation.—Samples of seed from about 30 markets in the Northern Region have been sown during three seasons at Samaru, and the percentages of seedling blight recorded when the plants were 3-4 weeks old. Disease incidence varied widely from market to market and from season to season, but seed from three markets—Nafada, Pindiga and Talasse, all in Bauchi Province—has consistently been more heavily infested than average. Seed from earlier pickings was generally more heavily infested than that from later pickings.

Other Diseases

Routine observations were made on other diseases throughout the season but none was found doing serious damage.

Both *Alternaria* and *Ramularia* leaf spots were noted with some apparent differences in varietal susceptibility. Samaru 26J was more susceptible to *Alternaria* but much less susceptible to *Ramularia* than introduced Tanganyika types.

A stem break affecting about 5% of young plants in one very well grown plot was found to be associated with, but not necessarily due to, *Rhizoctonia solani.* In general deaths of seedlings from disease are notably infrequent at Samaru. In one experiment with 18,750 seedlings losses from disease were 23 only.

Lint staining was found associated with *Nematospora gossypii, Aspergillus niger, A. fumigatus* and *A. versicolor* and also with a bacterium identified (by the Commonwealth Mycological Institute) as *Protaminobacter ruber* den Booren de Jong (IMI 78958).

Soil Microbiology

Preliminary qualitative and quantitative studies were made of the bacteria and fungi of the soil and rhizosphere, and of the fungi on the surface of cotton roots. The dominant root-surface fungi included *Cylindrocarpon radiocicola, C. heteronemum, Rhizoctonia solani* and sterile mycelia. *Fusarium oxysporum* was rarely recorded on the root surface, although it was comparatively common in the soil and rhizosphere. *Verticillium* spp. were not isolated from any substrate. This work has now been extended, in co-operation with the general

pathologist, to cover the effect on the microflora brought about by ten years mono-cropping of cotton, guinea corn and groundnuts, combined with a rotation of these crops, all treatments being with and without farmyard manure.

Dowpon on Cotton

Pot experiments showed that when Dowpon (dalapon) was applied to moist soil at up to 30 times the recommended rate of 8 lb per acre, it had decomposed sufficiently in two weeks not to affect the growth of cotton seedlings. Soil bacterial numbers rose tenfold in the week after application of high rates of Dowpon, but were normal again after a further week. Decomposition was much slower in drier soils.

Gibberellic Acid on Cotton

A study was made of the effects of gibberellic acid on cotton; the results have been published (Dransfield, 1961), the main conclusion being that GA is of no practical benefit to cotton in Northern Nigeria.

Entomology

BY

M. A. CHOYCE and W. REED

Cotton Pests in 1959—General Notes

Diparopsis watersi (*Roths.*). *Red bollworm.*—This is an important pest in the main cotton growing areas; a particularly severe attack developed on multiplication cotton at Daudawa in November. The only parasite recorded during the season was *Carcelia evolans* (Weid.) which occurred in large numbers at Daudawa. Emergence figures from long term Diparopsis pupae are incomplete but there are indications that the rate of parasitism was reduced by spraying.

No abnormal infestations of other bollworm were recorded.

Dysdercus spp. Cotton stainers.—The "spotted form" of *D. superstitiosus* (F.) was less common in the northern provinces than last season, but again caused considerable losses in the Riverain Area. Detailed observations on cotton and other hosts continued at Mokwa*, and showed that stainers could be found on one host or another throughout the year. At Samaru no stainers were recorded from mid January, when they left rama (*Hibiscus cannabinus*) and roselle (*H. sabdariffa*), until adults re-appeared in large numbers on kapok (*Ceiba pentandra*) in early April.

*Mr. J. A'Brook, Specialist Officer (Entomologist), Ministry of Agriculture, supervised entomological work on cotton at Mokwa, and we are indebted to him for details and results from that station included in this report.

The "banded form" of *D. superstitiosus,* which is much less common than the "spotted form" (see Pearson, 1958), was recorded at Lowlands and Mokwa.

Other species of stainers were rare; *D. fasciatus,* for example, was not seen on cotton at Mokwa but bred throughout the year on *Adansonia.*

Three species of parasites were noted at Samaru on stainers taken from millet. These were *Bogosiella fasciata* (F.) (Diptera, Tachinidae), *Allophora nasalis* Bezzi (Diptera, Tachinidae) and *Sarcophaga villa* Curran (Diptera, Sarcophagidae). The last named emerged from a collection of dead stainers, but the circumstances suggest that it was parasitic rather than saprophytic.

Sylepta derogata (*F.*). *Cotton leaf roller.*—This pest was widely reported during September, and caused some concern to extension workers, probably because the damage is so obvious.

Prodenia litura (*F.*). *Cotton leaf worm.*—Although several adults were taken in the light trap during November and December, the larvae were rarely found on cotton. In some areas severe infestations of this pest occurred on tobacco.

Oligonychus gossypii Zacher. Red spider mite.—Populations of mites were generally lower than in 1958 and resulting losses were negligible.

Storthophorus sp. Millepedes.—A district variety trial at Gusau had to be resown because of damage to seedling roots by millepedes, populations of which were estimated to be up to 40,000 per acre. The land had been heavily manured, and showed a tendency to waterlogging.

The Emergence of Adults from Diapause and Time of Flight of Diparopsis watersi (*Roths.*).

At Samaru emergence of adults from diapause pupae began in mid May, and continued at a low level until the end of August; thereafter numbers increased to a maximum in the first week of October, the last moths emerging at the end of that month.

As in previous years, these observations were made on pupae caged in concrete troughs. Although the soil conditions in these troughs did not duplicate the wide variety of field conditions that exist, the pattern of emergence was very similar to that shown by the variation in numbers of moths taken at light during the season.

Two light traps were used, one at Samaru and the second on the cotton multiplication farm at Daudawa. That at Samaru consisted of a 100 watt bulb with a dish reflector; at Daudawa, where electricity is

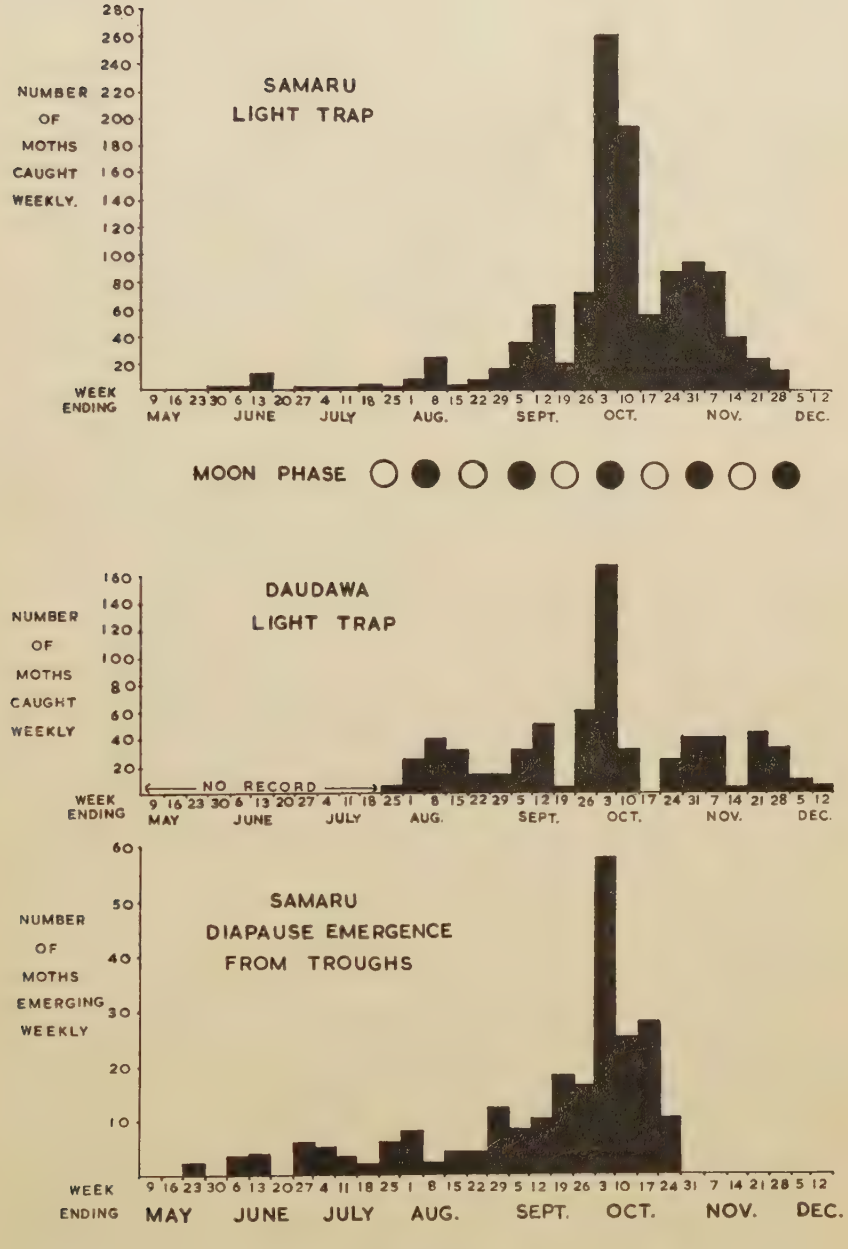

FIGURE 1

INCIDENCE OF *Diparopsis watersi* (1959)

not available, the trap consisted of a Tilley storm lantern standing in a tray of water. When these traps were tested 10 yards apart, moths showed a marked preference for the one operated by electricity.

The Samaru light trap was operated daily, with few exceptions, from dusk to dawn from the end of May. It was situated near a small plot of cotton, but attracted moths from a much wider area; the nearest large area of cotton was 200 yards away. Observations on the Daudawa trap, which was placed under cover but close to many acres of multiplication cotton, were taken from mid July to mid December. Observations on four moonless nights showed that the majority of moths were caught between 9 p.m. and midnight, none being taken after 1.30 a.m. Nearly all the moths appeared to be newly-emerged, and there were wide variations in the proportions of males and females.

Figure 1 shows the number of moths caught per week at Samaru and Daudawa, together with the trough emergence at Samaru. The fall in numbers caught during the weeks ending 22nd August, 19th September, 17th October and 14th November coincided with the occurrences of full moon, and was presumably due to the lower relative attractiveness of the traps during these periods.

Allowing for moon effect, the variation in moth flight is very similar to the corresponding emergence from diapause pupae, maximum numbers occurring in both cases at the beginning of October. Light trap catches continue after diapause emergence has ceased, owing to emergence of moths from short term pupae. Since the majority of pupae produced after mid November go into diapause, the observations confirm that only the small proportion of moths emerging before the October peak have time to produce more than one generation during a season.

Insecticide Trial at Samaru

Details of an insecticide trial at Samaru are given in Table 5. Boll and bud samples taken at weekly intervals from 21st September did not show any outstanding treatment differences. Stainers entered the cotton at the beginning of September and remained until the end of November. Bollworm damage, caused mainly by red and pink bollworm, averaged less than 20% on unsprayed plots.

Treatments containing endrin or DDT were significantly better than those without (1 and 2). It is possible that the rate of application of gamma BHC can be reduced below 0·25 lb per acre in the DDT/BHC mixture; this would be of importance in reducing the cost of insecticides on cotton, since the price of gamma BHC is about three times that of DDT.

TABLE 5

INSECTICIDE TRIAL, SAMARU, 1959

Insecticide (active ingredient per acre)	*Dates of application*									*Yield of seed cotton lb per acre*
	September			October				November		
	14	23	30	7	14	21	28	4	7	
1. Nil										606
2. g.BHC 0·25 lb	✓	✓	✓	✓	✓	✓				730
3. DDT 1 lb	✓	✓	✓	✓	✓	✓				774
4. DDT 1 lb + g.BHC 0·06 lb	✓	✓	✓	✓	✓	✓				866
4. DDT 1 lb + g.BHC 0·12 lb	✓	✓	✓	✓	✓	✓				913
6. DDT 1 lb + g.BHC 0·25 lb	✓	✓	✓	✓	✓	✓				868
7. DDT 1 lb + g.BHC 0·25 lb	✓		✓		✓		✓			744
8. Endrin 0·25 lb	✓	✓	✓	✓	✓	✓	✓	✓	✓	954
S.E.										±75

Design: 4 replications of 8 treatments; plot size 1/13·3 acres.
Fertiliser: 2 cwt superphosphate plus 2 cwt sulphate of ammonia applied broadcast June 11.
Cotton: Variety 26J, sown June 16.
Sprays: Applied by knapsack in 20 gallons water per acre.
Harvest: From November 16 to January 22.

Sowing Date of Sprayed Cotton

Yields from three date-of-sowing trials are given in Table 6. These confirm earlier results and again demonstrate the marked fall in yield obtained from cotton sown after the end of June.

TABLE 6

COTTON—DATE OF SOWING TRIALS, 1959

(*Yield in lb seed cotton per acre*)

Sowing date	*Samaru (Zaria Province)*	*Lowlands (Plateau Province)*	*Mokwa (Niger Province)*
25th-26th May	576	750	1192
1st-2nd June	689	831	1034
8th-9th June	703	778	1039
15th-16th June	691	958	1076
22nd-23rd June	683	942	951
29th-30th June	605	1018	914
6th-7th July	415	924	972
13th-14th July	226	790	438
20th July	—	621	256
27th July	—	494	199

Spray applications:—

Samaru: 5 to 9 weekly sprays, 1 lb DDT plus ¼ lb g.BHC in 35 gallons water, beginning 3rd September for earliest sowings, and 10th September for later sowings, by knapsack sprayer.

Mokwa: 6 weekly sprays, 1 lb DDT plus ¼ lb g.BHC in 10 gallons water, from 27th August, by Hahn Hi-boy sprayer.

Lowlands: 8 weekly sprays, 1 lb DDT plus ¼ lb g.BHC in 45 gallons water, beginning 1st September for earliest sowings, and 15th September for later sowings, by knapsack sprayer.

The trial at Samaru, covering just over two acres, consisted of four replications of eight sowing dates. The earliest sowing produced the most flowers during August, but flowering on all dates was depressed between late August and the third week in September because of waterlogging. Very few flowers opened on the late sown plots until after this period, production never reaching the level attained by earlier sowings.

Cotton Spraying at Lowlands, Plateau Province

An attempt to introduce improved methods of cotton growing and spraying on to the Resettlement Area at Talgwan gave encouraging results. An area of 30 acres was cleared from bush and ridged in time for sowing on 22nd June, by the 24 farmers concerned. Four sprays were applied between 23rd September and 23rd October.

Ridging of the land is not normally practised for any crop in this district, and the number of stands per acre proved to be only about half that recommended for cotton. The average yield from three half-acre plots was 540 lb per acre.

This yield is comparable with that obtained on Lowlands Experiment Farm, where 2 acres of cotton yielded 695 lb per acre after four sprays. A further two acres gave 937 lb per acre after six sprays.

Cotton Seed Multiplication, Daudawa

The whole of stages B and C multiplication cotton on the main farm, Daudawa, totalling 224 acres, was treated with insecticide during 1959. Sowing was completed between 22nd June and 5th July, and a tractor-mounted sprayer was used to make three spray applications between 8th September and 4th November. With the first two treatments, 1·23 lb DDT and 0·31 lb gamma BHC in 14 to 15 gallons of spray per acre were applied, these rates being increased to 1·95 lb DDT and 0·39 lb gamma BHC per acre for the third treatment.

Yields from the sprayed cotton, and from unsprayed cotton in the Daudawa area, were as follows:

Sprayed cotton

Main farm, stage B (39·5 acres) — 522 lb per acre.
Main farm, stage C (191·4 acres) — 584 lb per acre.

Unsprayed cotton

Main Farm, D.V.T. (mean yield) — 283 lb per acre.
Shemi, stage C (150 acres) — 264 lb per acre.
Tractor unit farm (40 acres) — 337 lb per acre.

Yields were lower than last season, but the increase due to spraying was probably of a similar order. The best field gave 760 lb per acre from 32 acres, compared with 1,005 lb per acre from a 30 acre field in 1958.

Good control of stainers and mirids was achieved, but later in the season red bollworm became numerous. Many of the bolls formed at this period failed to open normally; water stresses induced by the onset of the dry season may have contributed to this.

The edges of some fields showed a higher than average incidence of red bollworm. This was particularly noticeable when a cotton field was adjacent to land which had grown cotton last season, but which was this year under a different crop. The effect was presumably due to dispersal of adults emerging from diapause pupae in these fields.

Incomplete records show that the degree of parasitism of *Diparopsis* by *Carcelia* at Daudawa is less than at Shemi; this difference may have been induced by spraying.

Cotton Spraying at Mokwa, Niger Province

A spraying trial covering 100 acres was repeated, the insecticide being applied with a Hahn Hi-boy high clearance motorised sprayer. The cotton fields were divided into groups as follows:

Treatment A — 5 fields totalling 23½ acres.
Treatment B — 6 fields totalling 24½ acres.
Treatment C — 6 fields totalling 24 acres.
Treatment D — 5 fields totalling 22½ acres.

In addition, two fields of 8½ acres were left unsprayed.

The time and number of sprays, each giving 1 lb DDT plus 0·25 lb gamma BHC per acre, was varied for each treatment:

A — 5 sprays: August 24, 31, September 1, 7, 14, 28.
B — 4 sprays: August 24, September 1, 7, 14.
C — 3 sprays: August 26, September 5, 15.
D — 4 sprays: August 25, September 3, 8, 15.
(Omitting gamma BHC from 1st and 3rd sprays.)

Apart from initial technical difficulties during assembly, and when gaining experience in its use, the Hi-boy worked quickly and efficiently. Adjusted to deliver 10 gallons per acre and covering a swathe of 10 yards, it was estimated that 100 acres could be sprayed in a 10-hour day, given adequate organisation.

All the cotton was sown between 1st and 5th June, and fertilised at the rate of 1 cwt superphosphate and ½ cwt sulphate of ammonia per acre applied between 19th and 27th June.

The major part of the crop was harvested from mid October to early November, with a smaller picking in December. Yields of seed cotton were as follows:—

A — 779 lb per acre (76% clean).
B — 755 lb per acre (79% clean).
C — 780 lb per acre (72% clean).
D — 691 lb per acre (71% clean).
Unsprayed — 548 lb per acre (56% clean).

A few cotton stainers entered the crop in July, probably from a nearby field of *Urena lobata*; numbers increased rapidly during September on unsprayed cotton, but good control was achieved on treated fields until the spraying programme was completed.

Damage to green bolls attributed to bollworms and stainers is given in Table 7 as a percentage of the bolls examined at various dates. It followed the usual pattern—a high percentage damaged by stainers throughout the season, and an increasing number attacked by bollworm as the season advanced. On sprayed and unsprayed fields pink bollworm were most common; red and spiny bollworms, and larvae of the false codling moth, were also present.

Small numbers of red spider mites appeared in mid October; this pest only became locally abundant in mid November, and did not affect the yield of the crop.

Detailed costs of all operations were taken on this trial. The total cost of all mechanical and hand cultivations, plus cost of fertiliser, on the unsprayed fields was £11 9s. 5d. This is equivalent in value to 551 lb of seed cotton at 5d. per pound, about the same as the yield obtained. There is some doubt, however, whether the yield would have been as high as this had these fields not been surrounded by sprayed cotton.

TABLE 7

RECORDS FROM GREEN BOLL SAMPLES, MOKWA, 1959
(*expressed in percentages*)

Date	Treatment A				Unsprayed cotton			
	NAD	BW	BW/NBW	NBW	NAD	BW	BW/NBW	NBW
1st Sept.	28	1	2	69	6	2	2	90
8th Sept.	29	1	12	58	2	0	12	86
16th Sept.	50	2	10	38	8	0	8	84
23rd Sept.	50	4	5	41	0	0	12	88
30th Sept.	12	10	19	59	2	2	30	66
8th Oct.	36	5	12	47	8	0	14	78
15th Oct.	22	2	10	66	0	0	10	90
22nd Oct.	2	0	40	58	0	0	24	76
27th Oct.	0	0	42	58	0	0	40	60
3rd Nov.	0	0	91	9	0	0	98	2
10th Nov.	0	0	71	29	0	0	58	42

NAD = No apparent damage.
BW = Damaged by bollworm.
NBW = Damage caused other than by bollworms (mainly by stainers).
BW/NBW = Bollworm and non-bollworm damage.

The cost of the spraying treatments, including application, materials and depreciation on the spraying machine varied from £4 to £7 per acre. At the yield levels recorded, application of insecticide obviously did not give economic returns.

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Appendix

Origin and main characteristics of cotton strains mentioned in this report

Allen	The local variety of the Northern Region up to 1953. Allen Long Staple, together with other strains, was introduced from East Africa in 1912.
26C	A selection from Allen made in 1939, with higher yield, ginning percentage, and freedom from "nep".
26I	A sister strain of 26C.
26J	A derivative of 26C, being material from the line 26C/479-25. Higher yielding and earlier cropping than 26C, with higher spinning quality. Staple length between 1″ and $1\frac{1}{16}$″.
S49	A derivative of 26 C/49160; high spinning quality.
S52	A derivative of 26J, previously known as 26C/479-25-44; high yielding, but poorer spinning quality.

S56	A derivative of 26J, previously known as 26C/479-25 BCP/14; used to establish a modal bulk.
Ishan	The variety grown in the Western Region; *Gossypium barbadense.*
MU8A	A Malwa Upland strain from India, early and prolific, but with short lint and low ginning percentage.
BAR D28	A selection resistant to bacterial blight from a Gold Coast strain D28.

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PROGRESS REPORTS FROM EXPERIMENT STATIONS

The reports for the seasons up to and including 1950-51 were published in seasonal volumes; the following are still in print and available at 3/- per volume post free.

1923-25 (one volume), 1926-27, 1931-32, 1934-35,
1935-36, 1942-43 and 1945-46 to 1950-51.

From 1951-52 the reports from each territory were published individually each season. A few of the 1951-52 reports are out of print, but all others are available post free at 2/6 per report or £1 for the seasonal set.

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